

## Implementation of an Erosion Control Program to Reduce Sediment Loading Rates from Land-Based Sources to the Coral Reefs of Culebra, Puerto Rico



Punta del Viento Estates Development Area

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## Summary

This report summarizes our training and Best Management Practice (BMP) implementation project in Culebra, PR. Culebra is a small 6 square mile island off the east coast of Puerto Rico where nearshore coral reefs are being impacted by often poorly controlled development, tourism (the main industry on the island) and fishing impacts. The area is a jurisdictional priority for coral reef protection as it contains some of the finest reef diversity in Puerto Rico, the Luis Peña marine reserve and many quality reef areas that can be accessed from shore.

In previous studies by Ramos, Hernandez and Amador, unpaved roads have been identified as the major source of sediment transport to nearshore reefs in Culebra, PR as well as other locations in St. John, USVI. As a result the goal of the project was to directly reduce sediment loads by implementing erosion and sediment transport BMPs on high priority unpaved roads within Culebra. The work performed entailed 1) a training with machine operators that included a background presentation on sediment and other stressors that impacts reefs with specific examples throughout Puerto Rico and a presentation on the methods to control erosion from unpaved roads; 2) on-site training and implementation of a erosion and sediment control techniques for unpaved roads in the community of Punta del Viento Estates. Participating in the work were 8-10 machine operators, Culebra Public works staff and the major developer on the island with oversight and coordination from GLM COOP, Protectores de Cuencas and Ridge to Reefs.



Figure 1. Illustrates one of the road areas for stabilization in Punta del Viento

Approximately one half mile of road was stabilized with a number of practices including approximately 30 rock check dams, 5 inlet and outlet protection, 3 cross swales to convey water in small amount to native vegetation areas where water could be infiltrated and uptaken by plants. The main goal was really to distribute the runoff into as small as units as possible -- so it would have minimal time to pick up additional sediment, and so it could be effectively managed by natural vegetation and soils.

## **Workshop**

The workshop was attended by 10 people -- 6-7 machine operators/the major builder on the island and Municipal Public Works staff/ who also operates a bulldozer (all but one of the machine operators on the island attended the training). Roberto Viqueira with Protectores de Cuencas handled the logistics coordinating with the municipality, ACDEC (Culebra Environmental Agency), securing 17 square meters of stone from the main island and ensuring the machine operators would be able to participate in the training by meeting with them ahead of time and discussing the project.

Dr. Edwin Hernandez introduced and discussed the impacts of sediment and other stressors on coral reefs with the machine operators. Juan Amador, P.E. introduced the types of practices and how each one functioned as well as what was to be done the next couple of days.



Figure 2. Workshop and Participants



## **In-Field Training and Implementation Work**

An overview of the work that was to be done is provided in Figure 4 and Figure 5. The main changes to the original design were adding additional check dams to reduce velocity in the drainage channels and the inability to create a cross swale across the road at Restoration Site #2 because of a shallow existing water line (additional check dams were used to reduce the velocity of water flow to compensate for the limitation. Eduardo and Juan, the on-site engineers with GMA COOP, organized the personnel on the four backhoes who were all working on various aspects of the erosion control practices at the same time and they completed the work quickly. Our limitation to accomplishing even more beyond the scope was the limited amount of rock we had for the check dams and outfall protection.

The main practices installed were cross swales (Figure 3), rock check dams (Figure 6) and rock outlet protection (Figure 3). Cross swales were used to distribute the flow into smaller units before return to vegetation; rock check dams were used to slow velocities; and rock outlet protection was used to limit erosion and head cutting at outfalls.



Figure 3. Illustrates the construction of a cross swale and outlet protection

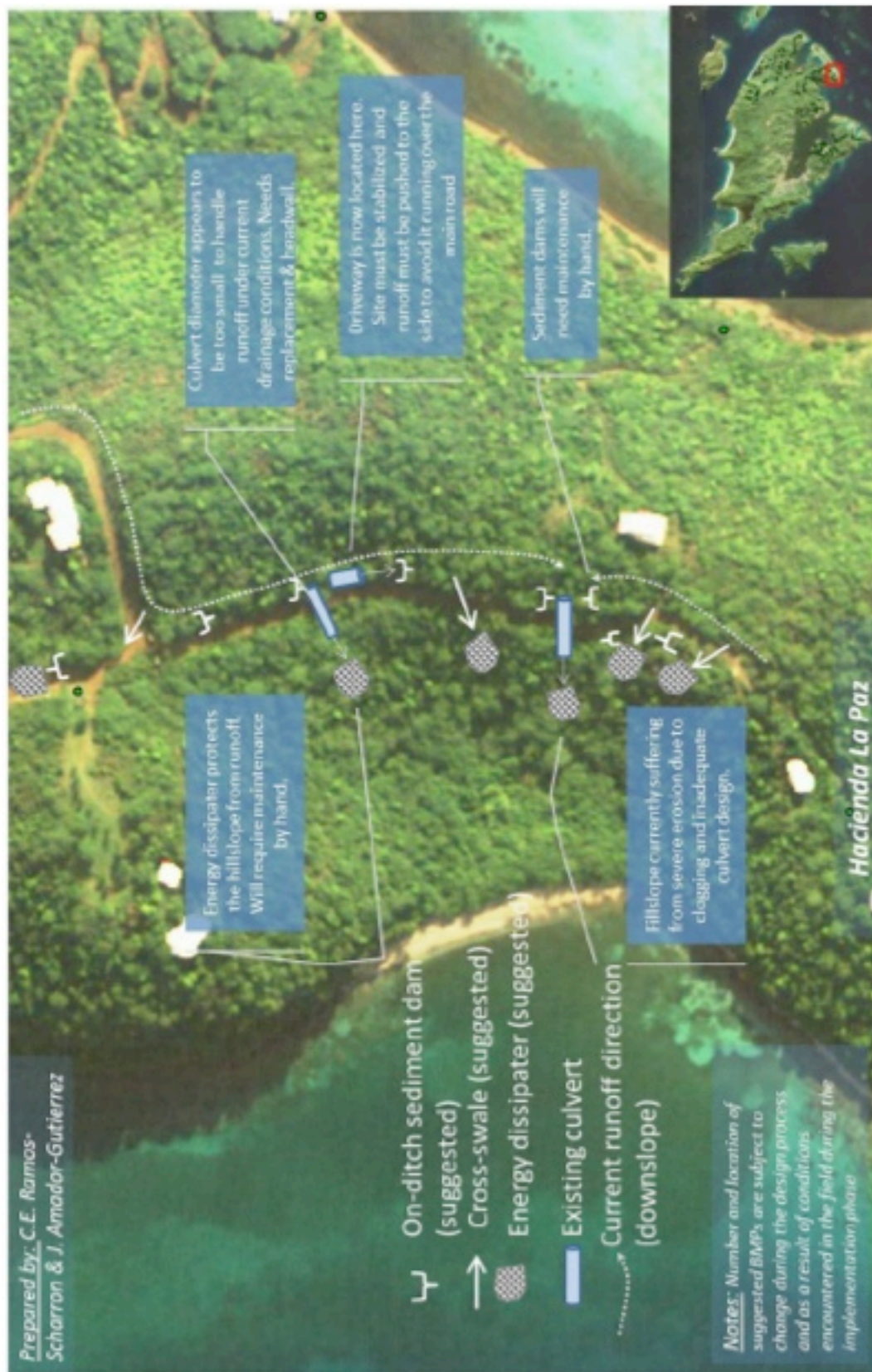


Figure 4. Restoration Site #1 and proposed practices





Figure 5. Restoration Site #2 and Proposed Practices

The operators were a quick study and made suggestions on how to improve techniques and on additional areas we needed to address. They also continued echo the need to have defined standards (agreed on by the agencies) for all unpaved and paved roads that incorporate proper BMPs. Contractors will be able to re-enforce standards having documentation from EPA/ACDEC and other relevant agencies so that additional impacts are minimized.

In the future some of the design work can be done as the stabilization is being completed as microtopography and utilities are not mapped by are in many cases only known by the operators themselves -- since they installed them. As a result in the field in our recent work, we had to change the designs due to the location of a water line in the middle of the road -- that limited any excavation on the road surface.



Figure 6. Note a series of check dams up the hill on the right (these slow the velocity of the water and drop out sediments) also the cross swale in Figure 3 was constructed midway up the hill to reduce the drainage area of the flowpath. The rocks in the foreground attenuate flows coming from the opposite direction.





Figure 7. On-site training with the Bahia Mosquito in the background



Figure 8. Example of a road on a steep slope that seemed to have minimal impact - two track drive - minimal impervious cover and crowned in the middle. This is a potential BMP for steep high use areas.



## **Additional Thoughts and Recommendations**

1. Development of a set of road standards for Culebra for dirt roads and paved roads that the operators are trained to construct and the criteria need to be enforceable standards are a critical step in the reduction of future impacts in Culebra. The integration of erosion and sediment control measures into those road standards is critical as well -- basic practices correctly installed including silt fencing, check dams and sediment traps. Agreement or general consensus by the agencies, machine operators and erosion control experts is important part of the process.
2. The integration of hydroseeding with road construction and rehabilitation is critically important as soil is disturbed and more vulnerable to erosion during construction -- and reconstruction. In addition, the provision of vegetation particularly vegetation that can establish a strong root system creates soil macropores and flowpaths for the infiltration of water and also help to reduce and attenuate flow velocities. Combining these practices is critical to increasing the efficiency of sediment trapping practices.
3. The sediment traps/pond that were implemented by NRCS in the past have been very important for limiting impacts of development to coastal waters and coral reefs in Culebra -- it is important that these areas be assessed for potential maintenance, and the possible construction of additional traps for areas of anticipated development.